Investigating Collaborative Creativity via Machine-Mediated Game Blending

Phil Lopes
Institute of Digital Games
University of Malta
Msida, Malta
louis.p.lopes@um.edu.mt

Georgios N. Yannakakis
Institute of Digital Games
University of Malta
Msida, Malta
georgios.yannakakis@um.edu.mt

Abstract

Can the creativity of humans be enhanced through mutual cooperation, or is it a detriment to their own individual creativity? Although most artists are known for their artistic individuality, some of the best creative works were achieved through mutual collaborative efforts. This paper proposes the study of a game blending system capable of combining user- and machine-generated content from multiple users and creativity facets (e.g., audio, visuals, narrative) for the creation of complete games. Supported by mixed-initiative design tools and human computation (crowdsourcing), users create facet-specific content, while getting stimulated by other creations on different facets by other users. Our research will investigate the ability for machine input into the collaborative process to yield games of higher novelty and quality for players.

Introduction

Digital game development — which consists of multi facet blending of art forms (such as level architecture, audio, and visuals) (Liapis, Yannakakis, and Togelius 2014) — is usually achieved through the mutual cooperation of individuals who work together bringing their expert knowledge and skill of a particular creative area of expertise (e.g. programming, design, music). When a musician, for example, is tasked to think of songs for a game, he is usually reminded of its thematic elements in order to stimulate his creative sensibilities towards the overall direction of the game's look and feel. This is usually achieved through other facets that go beyond a "musician's expertise", such as presenting narrative snippets, drawings or even prototype game-play. Thus a hypothesis can be made for the benefits of stimuli that expand beyond the domain of the creator (i.e. *outer-domain* stimuli): we argue that they foster the creative process and they influence the created artefact as the creator builds a richer analogical interpretation (Falkenhainer 1990) across multiple facets far beyond her domain. We believe that outer-domain stimuli would allow the human creator to approach the artistic endeavour with a higher degree of freedom and apply his own artistic style.

Mixed-initiative tools are designed on the basis of single users constrained to the domain of the creation (Smith, Whitehead, and Mateas 2011; Liapis, Yannakakis, and Togelius 2013); however, creativity can be expressed across multiple domains varying from painting, to music and narrative as in the domain of games. Mixed-initiative co-creation (Yannakakis, Liapis, and Alexopoulos 2014) dictates that machines can affect a human designer's lateral-path (De Bono 2010), by suggesting alternatives that are unconstrained by the designer's bias. In the study of Liapis et al. (2013) strategy game maps are designed by the users and variations of their current design are suggested by the machine in order to influence the user's lateral path and ponder about other viable solutions. However, it can be argued that suggestions beyond the domain's scope (e.g. level or map design) can stimulate the designer's creativity, open the possibilities for re-framing (Kelly and Gero 2014) and boost divergent (non-linear) thinking (De Bono 2010). We hypothesize that if, instead, designers were given music or narrative samples — either machine generated or human created — as a starting point of the design activity, such a process would potentially lead to more creative artefacts and, therefore more appealing games.

To test the above hypothesis we propose the development of a crowdsourcing game design system we name *Game Blender*, capable of hosting creations obtained through collaborative mixed-initiative creativity tools. The author (user of the system) will be asked to create based on a stimulus outside of the tools domain (e.g. write a story based on this piece of music). The crowdsourcing system acts as an evaluation method of the created content and a metaphorical "blender", that places the most novel and highest quality content together in order to create assemblages of partially playable games.

With the initial version of the game blender we aim to study the effects of how human creativity is affected within the blending of four different facets: audio, narrative, ludus and level architecture. This decision leaves out the game creativity facets of gameplay and visuals (Liapis, Yannakakis, and Togelius 2014) which will be considered in future versions of the game blender. The mixed-initiative tools will help us understand how different kinds of stimuli — both within (i.e. inner-domain) and outside (i.e. outer-domain) the tool's creativity domain (facet) — can affect the users' creativity. The output of this research will consist of a different approach to stimulate human creativity and game-design.

Background

In this section of the paper we will discuss background work and literature related to this study covering the areas of conceptual blending, crowdsourcing, mixed-initiative co-creation and procedural content generation in games.

Conceptual Blending

Conceptual blending, first proposed by Fauconnier and Turner (2008), is the human act of metaphorically "blending" various distinct concepts, which then result in a brand new structure with its own emergent properties. More precisely blending can be thought as a mapping between different conceptual spaces resulting in a emergent space, such as the blend of a spoon with a fork, for example resulting in a spork/foon, or of a house and a boat, leading to the word houseboat, which can be thought of as concepts of their own. The notion of blends have been extensively used within computational creativity theory (Veale 2012; Li et al. 2012) as a way of obtaining further emergent artefacts through the combination of concepts.

In the spectrum of game creativity the idea of blending, although not directly referred to it as such, can be found in works such as the Game-o-Matic (Treanor et al. 2012) where a graph of nouns and verbs are mapped to gameplay patterns in order to generate a game with a particular set theme. Another approach is through the combination of a game's code, by extracting thematic concepts and meaning, and combining it with the games' game-play patterns (Cook and Colton 2013).

With this work we intend to further explore the mapping along the multiple facets of creativity existent in games. We believe that the exploration of blended mappings with relation to music, narrative, ludus and level architecture can be be highly beneficial towards the creation of automatically generated game systems.

Crowdsourcing

Crowdsourcing methodologies have been extensively used in AI, particularly in generating and evaluating story artefacts (Li et al. 2013), visual images (Secretan et al. 2008), human behaviour prediction (Orkin and Roy 2007) and even weapon behaviours (Hastings, Guha, and Stanley 2009). Crowdsourcing consists of the solicitation of services, ideas, or content from a large community of individuals, who volunteer, in order to collaboratively achieve a common goal. Although this is true within our proposed system, the main difference is that a game is a multifaceted experience, which in order to develop through crowd-sourcing a facet must be one type of content from the whole. Artefacts generated through crowdsourcing systems tend to take into account one facet of creation, e.g. images or text, and not explore the combination of them, e.g. images and text. Users are tasked in evaluating and working within one facet, although it could prove fruitful having different users working on their preferred facets, and then blend these together to create a collaborative artefact between users and machine.

It is worth noting that our ideas of crowdsourcing are more aligned to community driven systems such as *Creatorverse* (Linden Lab, 2012), *Little Big Planet* (Media Molecule, 2008) or *Picbreeder* (Secretan et al. 2008), where creations are shared and rated within an online creative hub. Picbreeder, for instance allows users to create images through an evolutionary process, where they can be shared/rated and further evolved by other users. Such a human computation approach is vital for the system we propose, as created content is not only a means to support game blending but also stimulate other users in the community.

Mixed-Initiative Co-Creation

Mixed-Initiative systems consist of adjutant programs capable of assisting users with the automation of minimal tasks during the creation process. Tools such as Sentient Sketchbook (Liapis, Yannakakis, and Togelius 2013) and Tanagra (Smith, Whitehead, and Mateas 2011) help designers in the creation of maps or levels, by suggesting alternatives that comply with constraints imposed by the human designer. For our study we explore Mixed-Initiative Co-Creativity (MI-CC) (Yannakakis, Liapis, and Alexopoulos 2014) through multiple users and the crossing of domains of stimuli, where the system acts as a creative adjutant that stimulates the human creator along the creation process.

Mixed-initiative co-creation is still a rather unexplored field, that has found applications within poetry (Kantosalo et al. 2014) and level design (Liapis, Yannakakis, and Togelius 2013; Smith, Whitehead, and Mateas 2011), with lateral thinking (De Bono 2010) and creative emotive reasoning (Scaltsas and Alexopoulos 2013) its key theoretical principles. Within the above theoretical frameworks of human creativity the impact of surprising (or simply random) external stimuli is key for altering pre-conceived notions of the human creator. Such a stimulus is necessary and usually apparent in game development, as developers are tasked in creating content with a particular theme, or from some initial concept. The *re-contextualization* core concept of later thinking suggests that establishing already known pre-conceived solutions into foreign environments can help users exploit the ideas of familiarity and develop these further.

With this work we intend to exploit and further develop the ideas of mixed-initiative co-creativity by formally analysing the effects of multifaceted stimuli on the human designer and their impact on the designer's ability to be creative.

Procedurally Generated Games

Although Procedural Content Generation (PCG) has been a widely explored field (Togelius et al. 2011), only recently has there been more emphasis on generative systems that can operate in multiple facets of a game simultaneously. Procedural generated games has been a rather active field in recent years with various strides being made, such as the generation of fully playable board-games (Browne 2008), or video game mechanics (Zook and Riedl 2014). Studies with the Angelina system (Cook, Colton, and Gow 2014) and the soon to be *General Video Game AI Competition*[1] have made great strides in the advancement of the field.

[1] http://www.gvgai.net/

This work will build on these foundations but focuses mainly on the collaborative creation aspect, and not on fully machine authored content. We expect to generate games where users solely create fragments of the whole game, through crowdsourcing, which is then filtered and blended through the machine by "cherry-picking" the combination that best suits its constraints and parameters.

The Game Blender

The game blender is a crowdsourcing system capable of generating games through the blending of multifaceted, content created by multiple users (Figure 1). The blender is supported by a number of facet creation tools, whose created artefacts map to all of the six creativity facets existent in games (Liapis, Yannakakis, and Togelius 2014). For this initial study, however, we will support and explore four of these facets: audio, narrative, ludus and level architecture. Crowdsourcing will also act as an evaluation for the created artefacts, which consists of an associative cumulative value of user annotations — such as the number of uses, likes or artefact ranking — and will provide users with outer-domain stimuli through the tools.

Blended artefacts will consist of partially playable games, which are created through the act of a metaphorical "blending" of the multifaceted artefacts that are within the game blender system. Blended creations can be initialized by users themselves, by defining a set of parameters, or through a "routine blend" (e.g. the game of the day). Eventually users will also be able to rate (or rank) and share blends. The blended games will consist of very simple 2-dimensional games (i.e. limited by the game design tool), where the player and non-player characters are represented through abstract components and simple movements.

All blends will be required to have one creation of each game facet of those offered, however other types of constraints might be explored further. Creations will have an associated value determining its quality (via crowdsourcing) and a novelty value, obtained through the analysis of and comparison with other content within the repository. The blending of creations will be explored from a bottom-up perspective, following Richie's (2007) criteria on measuring creativity. In order to explore how to achieve blends capable of maximizing quality and novelty, various metrics will be developed taking into consideration each creation's value, e.g. a weighted sum of their quality/novelty score. Other ad-hoc designed metrics might also be explored such as the generation of games that maximize a typicality value (e.g. generate a game similar to Pacman).

In order to blend different types of facets, we will explore varied mapping techniques found in literature (Treanor et al. 2012; Brown 2012). We will also explore ideas already popular in existent game asset tools such as triggers, where content can be mapped to particular events indirectly (e.g. such as when a piece of narrative/music should be shown/played at a particular spot).

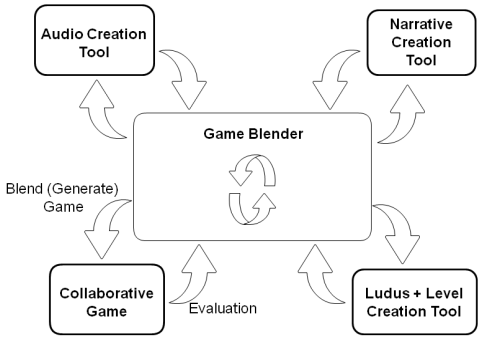

Figure 1: Conceptual representation of the game blender. **Outward connections from game blender**: represent outer-domain stimulus from creations that are already existent within the blender, and at the same time consists of an evaluation method which rates content based on user choice of stimuli. **Inward connections to the game blender**: represent the allocation of the multifaceted creations within the blender, created by a user using that respective tool.

Artefact Creation Tools

Artefact creation tools act as the content support mechanism in order for the game blender to work. Designers will use these tools in order to feed the game blender, so that in return can provide further stimuli to the rest of the community, and blend games across different creativity facets from designer created content.

All tools will apply the MI-CC (Yannakakis, Liapis, and Alexopoulos 2014) paradigm, where users will be presented with stimuli before and during the creation process. The type of stimuli presented will consist of both outer-domain and inner-domain artefacts, with the intention of exploring the affects of how different types of stimuli can affect a user's lateral thinking path. These tools can also offer the capacity for collaborative creativity, allowing individuals to share their creations in order for other creative users to modify them further.

For the system to be appealing to not just experts within each domain field, these tools will be designed with a *magic crayon* (Gingold 2003) paradigm, so that even the layman musician, game designer or author can freely explore and share his creation. The narrative tool, which is currently being prototyped, consists of a digital story-telling game similar to analogue games like *Once Upon a Time* (Atlas Games, 1993), where users gradually construct a narrative along a graph, where each node consists of a written fragment in which the creator was affected by a stimulus. The Sentient Sketchbook (Liapis, Yannakakis, and Togelius 2013) will serve as the basis for our study for the game design tool, where we will combine both the level artefact facet and the ludus facet so that even the act of game creation can be "playful" to an extent. Finally for the audio creation tool we will look at systems like MaestroGenesis (Szerlip, Hoover, and Stanley 2012), although we envision a more gameful and streamlined system.

Stimuli presented to the user will consist of community

created content for all facets, and machine generated, for both the audio and level architecture facet. Machine generated suggestions will be obtained through the use of variants of evolutionary computation and functional scaffolding (Szerlip et al. 2012), although other types of methods are currently explored.

Conclusions and Future Work

In this paper we proposed the creation of a set of tools for investigating the impact of outer-domain stimuli on fostering creative thinking, compared to inner-domain stimuli. In order to promptly and rigorously test our hypothesis, controlled experiments will be held comparing the effect of different type of stimuli on humans, for all mixed-initiative creation tools. We also proposed the development of a communal platform capable of blending games, from both the user- and the machine-generated content. The authoring tools will be the stepping stone for this platform, and will be the first to be prototyped and developed. Experimentation with blending methods with each combination of multifaceted artefacts will be conducted and evaluated with humans.

With this research we hope to produce tools with the capabilities of interweaving multiple game facets in order to generate playable content, while simultaneously provide multifaceted stimuli capable of enhancing human creativity, offering designers new and innovative ways of approaching creativity and communicating ideas.

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